

NASA Office of Life &
Microgravity Sciences &
Applications (OLMSA)

Organization & Operations



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Sciences & Applications (OLMSA)

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1. WHY OLMSA

1.1 OLMSA Outcomes and Impacts

NASA's Office of Life and Microgravity Sciences and Applications (OLMSA) seeks to advance scientific knowledge, enable the development of space for human enterprise, and transfer the knowledge and technologies that we develop as broadly as possible. We endeavor to enable and utilize the potentials of human space flight in order to improve the quality of life for people on Earth. The results of the work that OLMSA sponsors can be summarized as a series of medium- and long-term outcomes.

Increasing Fundamental Knowledge: Space flight allows us to utilize environmental conditions for research that we cannot achieve on the surface of Earth. Of greatest significance, space flight enables us to use gravity as an experimental variable. Gravity plays a role in most of the everyday biological, physical, and chemical processes upon which human health and industrial productivity depend. Through space flight, OLMSA enables researchers from the public and private sectors to build upon ground-based research and use microgravity to expand scientific understanding in fields ranging from fundamental physics to basic biology and chemistry.

Looking After Health: OLMSA works to protect the health of American astronauts and the NASA workforce while using the microgravity conditions of space to advance medical knowledge. This knowledge can be applied to keep our astronauts safe and healthy during space flight and to increase the health and well-being of people on Earth. Advances in health care first developed for the space flight environment have been and will continue to be applied on Earth to enhance public health.

Improving Industrial Processes on Earth: Our efforts to address the challenges of space flight and to conduct research in the unique

environment of space create valuable knowledge, technologies, and expertise that we seek to share with the broadest possible audience. We are dedicated to returning value to the American taxpayer by transferring our knowledge and expertise to industry. Microgravity research into fluid and combustion physics, materials science, and biotechnology will advance the efforts of American industrial partners.

Researching Tomorrow's Products: In space as on Earth, the benefits of research are most efficiently distributed to the public through commercial enterprises. OLMSA facilitates the use of space by commercial firms developing new products and services. Commercial enterprises conduct research using the low gravity and vacuum properties of the space environment to develop new and improved products, ranging from drugs to computer components.

Enabling Exploration: Space flight presents us with innumerable biomedical, engineering, and technology development challenges. OLMSA conducts ground- and space-based research and technology development to enable mission success and efficient operations in the space environment. For example, OLMSA conducts research on life support systems, fire detection and suppression in space, and health maintenance in space. Ultimately, this research, combined with other NASA research on launch vehicles and space systems, will open the space frontier for human exploration, vastly expanded scientific research, and commercial development.

1.2 OLMSA Strategic and Policy Framework

OLMSA's processes for selecting specific research, development, and technology projects is based on policy direction, including the following:

- federal regulations,
- authorizing and appropriating legislation,

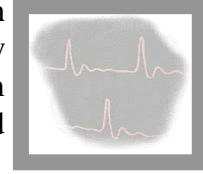
- the *Space Act of 1958*,
- the *National Space Policy*,
- other Administration policy such as *Science in the National Interest*,
- NASA policy directives,
- the *NASA Science Policy Guide*,
- the *NASA Strategic Plan*, and
- the *Human Exploration and Development of Space Strategic Plan*.

OLMSA is in partnership with the Office of Space Flight in NASA's Human Exploration and Development of Space (HEDS) Strategic Enterprise. Our primary source of general strategic direction is NASA's *Human Exploration and Development of Space Strategic Plan*. The Plan identifies a series of goals and objectives for OLMSA (see Figure 1). Within the framework established by the HEDS Plan, OLMSA develops detailed performance goals with milestones and discrete products that can be evaluated on an annual basis.

The HEDS strategic plan does not include criteria for prioritizing goals and objectives. OLMSA accomplishes the necessary prioritization based upon policy guidance and consultation with customer communities as part of the annual budget development process.

As discussed below, OLMSA regularly consults

with a broad advisory structure that includes the committees of the National Research Council (NRC) and the NASA Advisory Council (NAC). The NASA and HEDS plans—and many of the policies that establish our strategic framework—have been developed with input from this advisory structure as well as from other customers and stakeholders.



2. WHAT IS OLMSA

2.1 The OLMSA Research Programs

OLMSA pursues its research goals through the following programs:

Advanced Human Support Technology

- Provides cutting edge technologies for the support of humans in space.

Biomedical Research and Countermeasures

- Promotes the health, safety, and performance of space crews.
- Investigates the biomedical effects of space flight to provide the biomedical support required for future human exploration and development of space.

Goals of NASA's Human Exploration & Development of Space Strategic Enterprise*

- Explore the Space Frontier
- Expand Scientific Knowledge
- Enable Humans to Live and Work Permanently in Space
- Expand the Commercial Development of Space
- Share the Experience and Benefits of Discovery

* Draft, *HEDS Strategic Plan*, February 2000



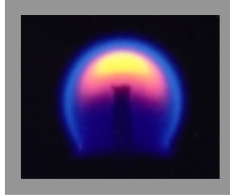
Figure 1

Fundamental Biology

- Investigates the interaction between gravity and basic biological processes using living systems that range from simple cells to humans.

Microgravity Research

- Uses space as a laboratory to explore the nature of physical phenomena, contributing to progress in science and technology on Earth.
- Studies the role of gravity in technological processes, building a scientific foundation for understanding the consequences of gravitational environments beyond Earth's boundaries.



Space Product Development

- Facilitates the use of space for the development of commercial products and services.

Within each of these programs, OLMSA may support:

- 1) fundamental research driven by an emphasis on expanding scientific knowledge;
- 2) mission-driven research, improving knowledge and technology for human space flight and exploration; and/or
- 3) applications-driven research, which seeks to transfer knowledge, expertise, and technology to an appropriate partner or partners.

2.2 OLMSA Agency-wide Policy Responsibilities

OLMSA programs and functions fulfill a number of roles for the Agency. OLMSA oversees the protection of human research subjects and the use of animals in all NASA research and training exercises. Additionally,

OLMSA is responsible for the health of both astronauts and Agency employees. In fulfillment of this latter duty, OLMSA leads the Agency's efforts on NASA Headquarters and Field Center Medical Boards and the Occupational Health and Safety Executive Board.

Protection of Human Research Subjects

OLMSA's policy regarding protection of human research subjects follows the provisions of NASA regulations contained in 14 Code of Federal Regulations (CFR) Part 1230 and 45 CFR Part 46, "Protection of Human Subjects," promulgated by the Office of Science and Technology Policy. The policy is also governed by NASA Policy Directive (NPD) 7100.8C, *Protection of Human Research Subjects*. NASA Center Directors establish an Institutional Review Board (IRB) to review all ground-based and flight research involving human subjects in which their Center participates. All research involving human subjects, including flight crews, performed in NASA spacecraft is also reviewed by the IRB at Johnson Space Center (JSC). The IRB must secure the informed consent of any human research subject before tests can commence. Risks to human research subjects are minimized to the greatest extent possible during the testing phase, and testing is immediately suspended upon injury, illness, disease, or request of the subject.

Animal Subject Care and Use

All NASA work involving the use of animals in research or training activities adheres to NPD 8910, *Care and Use of Animals*. OLMSA is responsible for ensuring that all NASA Centers and affiliated facilities follow the directions set forth by the National Institutes of Health and the National Research Council in this area. Additionally, OLMSA oversees the compliance of all NASA animal holding facilities and/or breeding colonies within the guidelines and recommendations of the *Guide for Care and Use of Laboratory Animals* and the American

Association for Accreditation of Laboratory Animal Care (AAALAC).

Medical Policy Board

The NASA Medical Policy Board (MPB) establishes medical policy for NASA. Chartered by NASA Policy Charter (NPC) 1152.76 and associated with NPD 8900.1E, the MPB is chaired by the Chief Medical Officer (CMO) from OLMSA and consists of physician membership from JSC, ARC, and KSC. In addition, physicians external to NASA may also contribute to the MPB. The MPB develops medical policy and provides stewardship and oversight of all medical activities in support of human space flight. The MPB approves medical selection and retention standards for astronauts and addresses any issues that can not be resolved by the JSC Aerospace Medicine Board. It also provides prioritization of critical questions in life sciences and directs that special studies be established to further understand those phenomena that occur in space flight and that affect crew health.

Aerospace Medicine Board

The NASA Aerospace Medicine Board (AMB) establishes spacecraft and aircraft crewmember medical standards for NASA. Chartered by NPC 1152.76 and governed by NPD 8900.3E, the AMB is chaired by a senior JSC medical officer designated by the JSC Director. It is the responsibility of the AMB to consider the medical qualifications of astronaut-candidate finalists during the astronaut selection process. In addition, the AMB conducts annual medical certifications of astronauts with flying duties for NASA aircraft. The AMB also has the authority to conduct a review of the findings from space flight and aviation-related medical examinations and to make determinations on specific cases. The AMB recommends to the MPB criteria and procedures needed to designate examining facilities for medical certification for space flight.

Occupational Health and Safety Executive Board

The Occupational Health and Safety Executive Board (OHSEB) is chartered by NPC 1150 and governed by NPDs 5100.1 and 8610.13A. The Executive Board ensures that support is provided for the occupational health program to meet externally mandated occupational health requirements and to provide effective, uniform basic health services to employees of the Agency. The Associate Administrators for OLMSA and Safety and Mission Assurance chair the OHSEB. The Executive Board serves as a forum for reviewing Agency policies, practices, and issues as they relate to the quality and content of the occupational health program. OHSEB also addresses questions arising about the impact of occupational health requirements on institutional resources.

The OHSEB has one standing subcommittee: the Health, Environmental Management, and Safety Subcommittee (HEMSS). The HEMSS advises the OHSEB on issues that require coordination at the interface between associated regulatory compliance functions and policy development of the respective occupational health, environmental management, and safety programs critical to the Agency's leadership role in the maintenance of all aspects of health and safety.

2.3 The OLMSA Operational Functions

OLMSA is also an operational organization conducting the following functions in health research:

Space Medicine

- Defines medical requirements for space flight.
- Establishes requirements for medical care to support human space flight.

Occupational Health

- Ensures the health and safety of all NASA employees.
- Manages research related to NASA workforce health issues.

Mission Integration

- Integrates research into missions involving human space flight

The OLMSA programs and functions support the goals of the HEDS Strategic Enterprise. Specific

programs focus on objectives that are organized under a particular goal; however, each of the programs broadly supports the entire set of HEDS goals. Figure 2 identifies the primary connections among HEDS goals and OLMSA programs and functions.

2.4 OLMSA's Emphasis on Interdisciplinary Research

OLMSA's research program—including both ground-based and space flight investigations—is extremely diverse. Each of the research programs may be subdivided into multiple disciplines. For

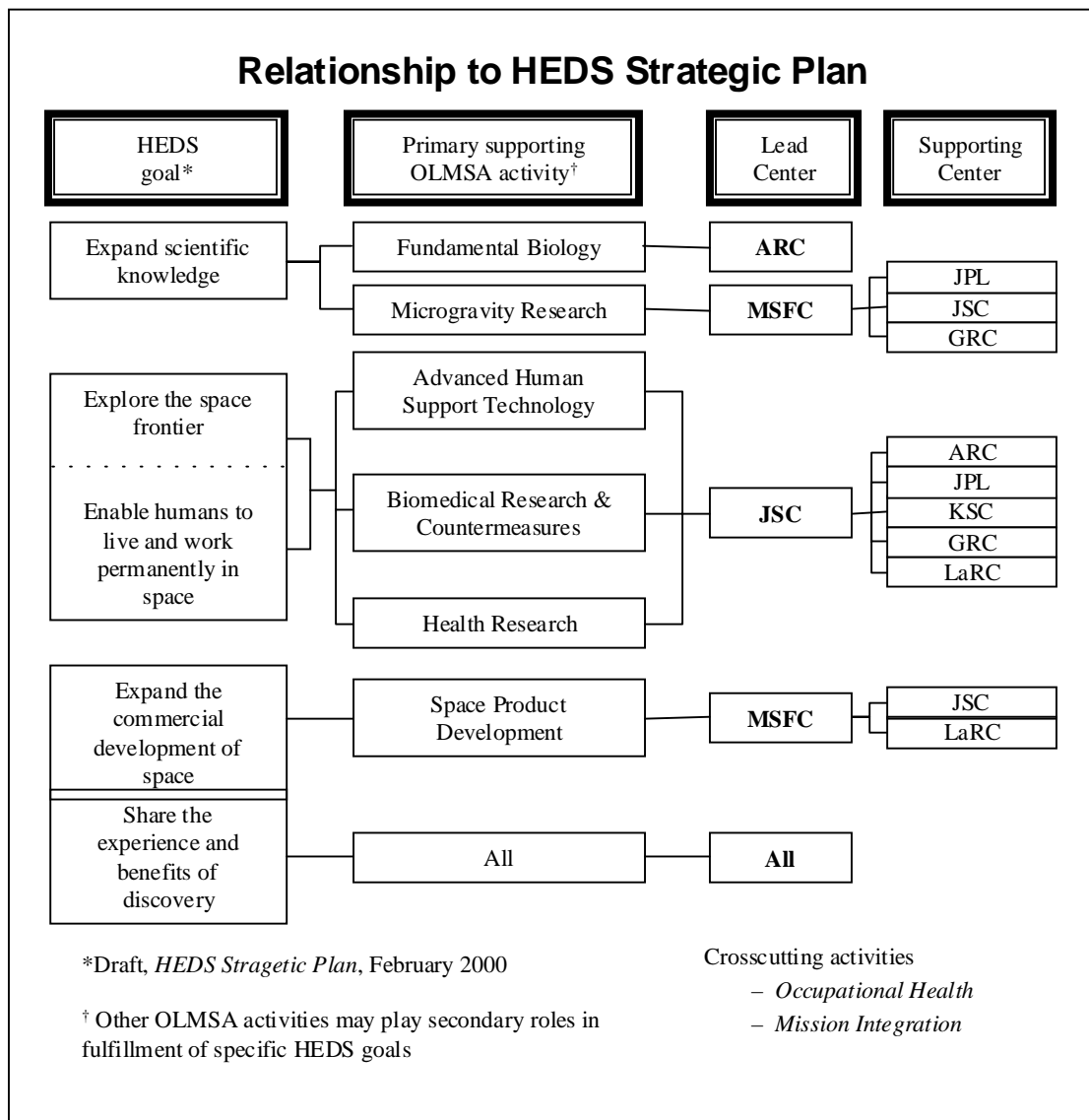


Figure 2

example, the Microgravity Research program encompasses biotechnology, combustion science, materials science, fluid physics, and fundamental physics. In the life sciences, OLMSA's Biomedical Research and Countermeasures program includes studies of virtually every system of the body as well as radiation health. Similarly, the Space Product Development program includes research in structure-based drug design, biotechnology, agriculture, and materials science. The theme that unites this array of disciplines is the importance of the space environment—especially control over gravitational forces for the particular experiments selected. A second unifying characteristic is the experimental, laboratory-style approach that each of the disciplines employs. OLMSA is the NASA research organization responsible for conducting controlled, repeatable experiments in space.

OLMSA's multidisciplinary character is an important strength. For example, the fluid physics OLMSA studies in pipes may elucidate the changes observed in the absorption of nutrients and drugs in the intestinal system. Physical and chemical processes underlie biological processes on Earth and in space, but the uniqueness of the space environment highlights the connection between and raises the importance of interdisciplinary research.

3. HOW OLMSA DOES BUSINESS

OLMSA's programs in research and technology development rely on broad participation by researchers from academia, other government agencies and departments, the commercial sector, and NASA field centers. For FY 1998, OLMSA-funded researchers were spread across 42 states. Of these investigators, over eighty five percent were extramural—that is, outside of NASA. In selecting investigations and projects to support—and ultimately for access to space—OLMSA follows different but closely related processes for scientific research, commercial research, and

technology research and development. These processes ensure that only highly competitive, quality research is supported by NASA and the HEDS Enterprise. Policy for these processes is established in the *OLMSA Policy on the Review, Selection, and Support of Research* (attached as Appendix A). The OLMSA policy covers all investigations (any project or task) funded or supported from any of the following sources: a program grant, a science center or institute, a NASA Specialized Center for Research and Training (NSCORT), a Commercial Space and Technology Center (CSTC), or a Commercial Space Center (CSC). The OLMSA research selection policy does not apply to non-research activities in operational medicine, the implementation of countermeasures, or to wholly commercial activities for which selection does not require OLMSA approval. The quality, relevance, and effectiveness of the solicitation, review, selection, and termination processes are reviewed annually with the OLMSA Associate Administrator and periodically with the relevant NASA advisory committees. An external assessment of these processes is sought every four years from the National Academy of Sciences and the National Academy of Public Administration.

All non-commercial research, whether conducted by NASA, the private sector, or academic researchers, must pass through a rigorous peer-review screening process. OLMSA does not employ a separate research selection track for exploration or mission-oriented research. Such research, whether basic or applied, passes through the competitive peer-review process. OLMSA does not generally solicit proposals on a mission-specific basis but maintains a queue of worthy research that is funded as opportunities become available. All researchers are expected to publish their results promptly in the open literature, unless any period of exclusive use or commercial proprietary concerns preclude doing so.

The relative priority among fundamental research, research oriented toward near-term benefits and applications, and research oriented toward enabling space exploration and operations is established at NASA Headquarters. Priorities are set while developing budgets, writing research proposal solicitations (NASA Research Announcements), and selecting from among peer-reviewed proposals.

3.1 Selecting and Funding Scientific Investigations

OLMSA begins its process for selecting scientific research by consulting with the scientific community through a series of working groups (see Figure 3). Based upon input from the working groups, as well as strategic considerations of mission needs and

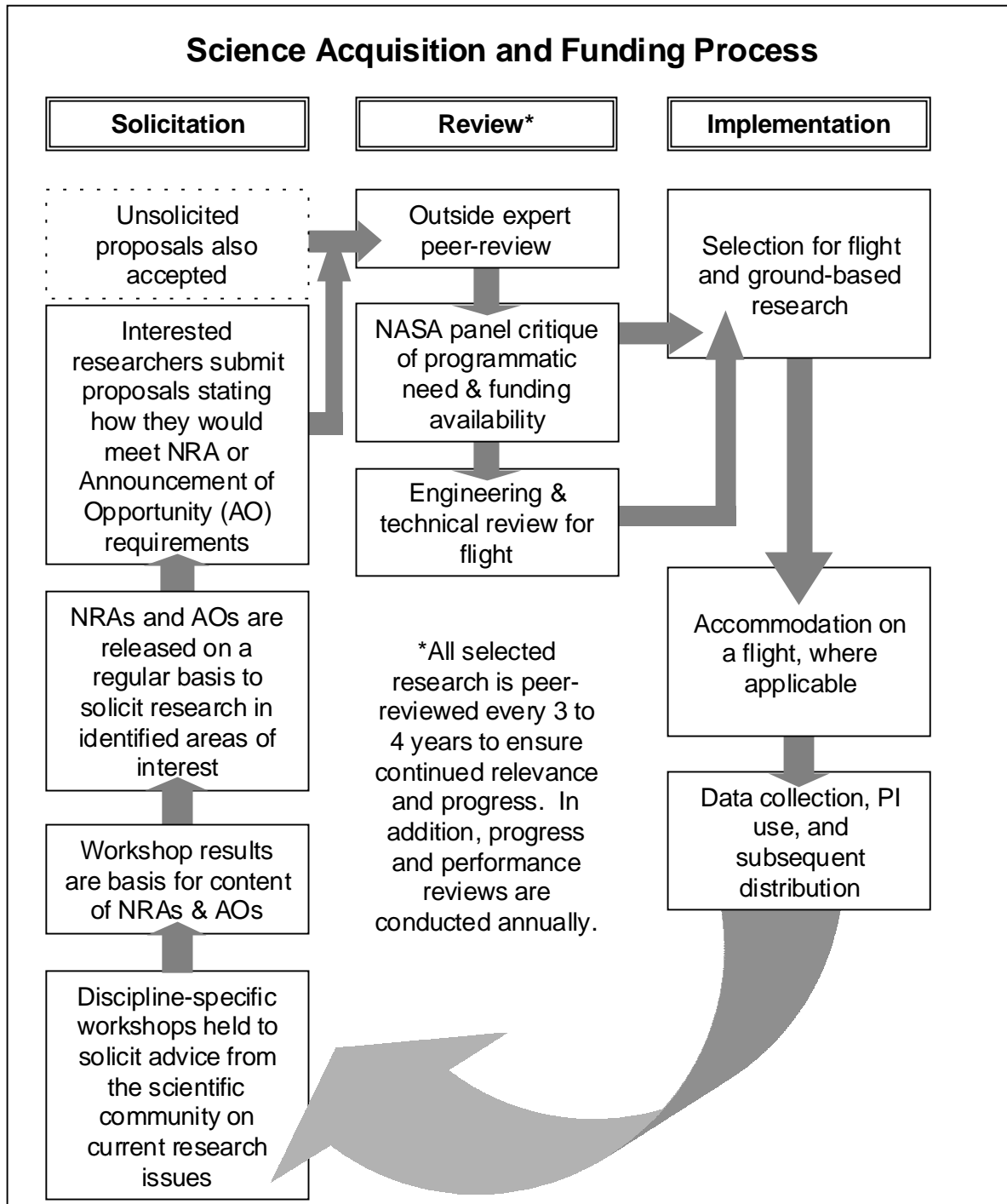


Figure 3

opportunities, OLMSA drafts appropriate NRAs. The NRAs are broadly distributed through open solicitations for proposals. The NRAs define general areas of research, including mission enabling research and general scientific research. Optimally, NRAs are platform independent—oriented toward scientific disciplines and questions rather than specific flight opportunities. NRAs are released on an annual schedule in some scientific disciplines and every two years for other disciplines. Once OLMSA receives proposals in response to an NRA, peer review panels composed of disinterested outside experts review and score the proposals. OLMSA manages the peer review process at NASA Headquarters. OLMSA management ultimately makes selection decisions based upon peer review scores, panel critiques, programmatic need, and funding availability. All selected research is re-reviewed every two to

four years. Investigators are required to submit annual reports to OLMSA on research progress and are encouraged to publish their results. Researchers retain exclusive access to their data for one year from the date when they receive it. After one year, all data and samples are archived and accessible to interested parties. Refer to Headquarters Office Work Instruction (HOWI) 8000-U003 for a detailed description of the research solicitation, evaluation, and selection process.

3.2 Selecting and Funding Commercial Research

Commercial research is market driven and must reflect the need for new or improved products. NASA's traditional approach for developing commercial research employs Commercial Space Centers (CSCs) and Commercial Space

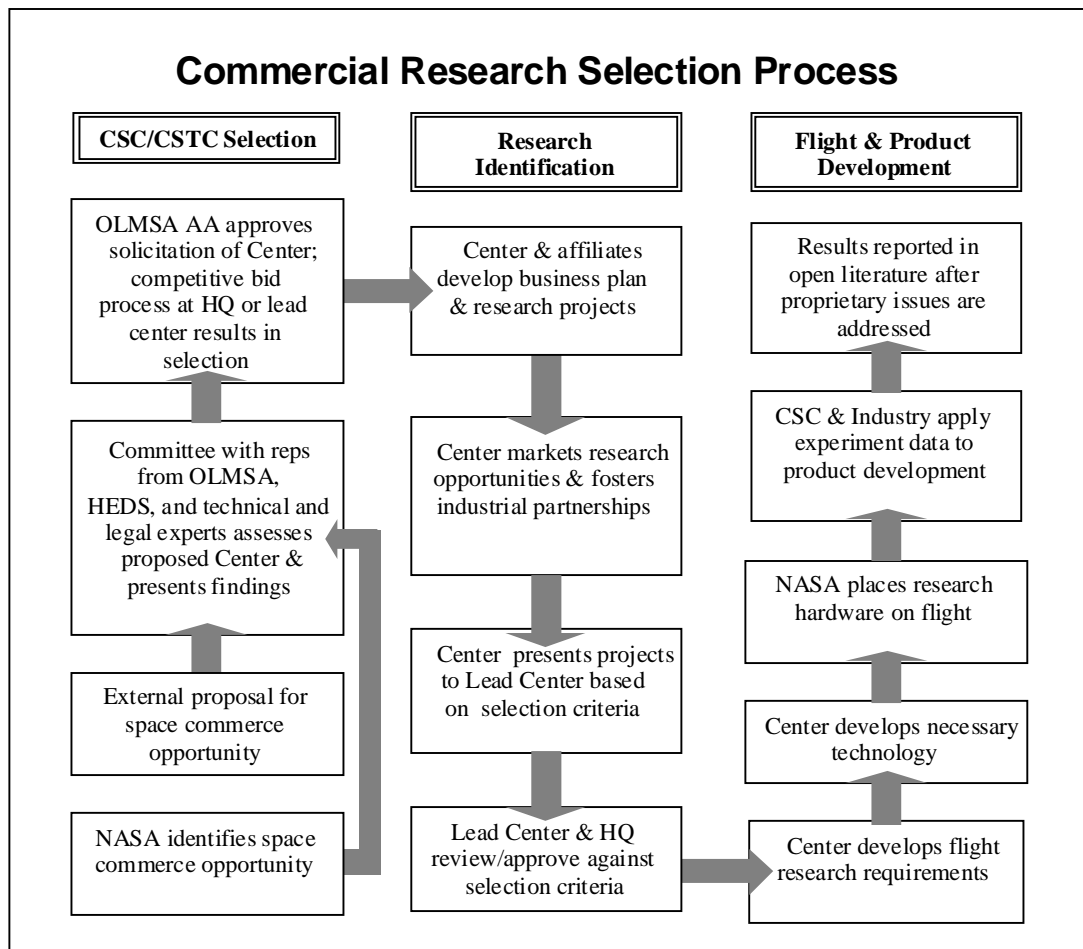


Figure 4

Technology Centers (CSTCs) that are jointly funded by NASA and a consortium of industry affiliates and academic institutions (see Figure 4).

Commercial research efforts receive support based upon the establishment of partnerships with the private sector and their commitment of resources to bring products into the marketplace. Research efforts must also have clear product development and market transition plans. Most of the research effort is conducted with the CSCs and CSTCs and their commercial affiliates; however, access to space may be provided for a commercial firm in support of a space product initiative. For each commercial research payload flown on a Shuttle mission, International Space Station flight increment, or other suitable platform, CSCs and CSTCs incur a charge of \$1000/lb, not to exceed \$20,000 per flight. The maximum charge to a CSC or CSTC in fiscal year is \$50,000, and the OLMSA Associate Administrator may waive this fee under special circumstances.

3.3 Selecting and Funding Technology Projects

OLMSA establishes directions in technology research and development based upon the goals and objectives of the HEDS Enterprise and upon advice from the OLMSA, HEDS, and NASA chief technologists. Selection of specific technology tasks mirrors the selection for other program tasks. Technology tasks for science

programs are identified by peer review (see Figure 5), and commercial technology is developed if required as a part of industry's space product development (see Figure 4). OLMSA has recently initiated an effort to encourage "technology infusion," an approach to update the technology of Station research facilities by forming partnerships with industry or other government agencies.

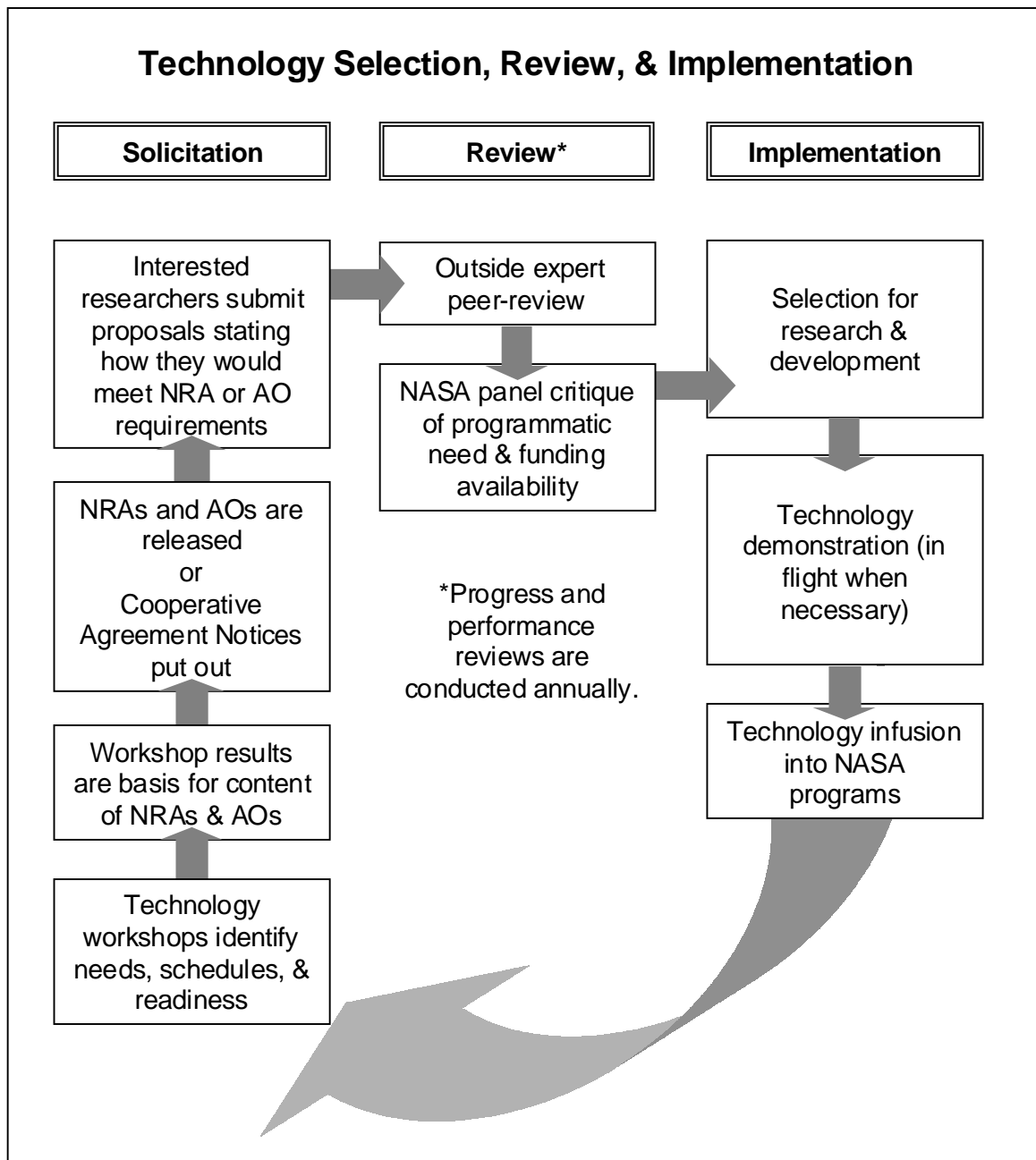


Figure 5

4. STRATEGIC ADVICE & PROGRAM EVALUATION

4.1 Program Advisory Structure

OLMSA depends upon the National Research Council (NRC) and the NASA Advisory Council (as well as their subcommittees) for advice and

guidance as it develops its goals and programs (see Figure 6).

The NRC is OLMSA's principal source of external strategic advice. The NRC provides expert advice and analysis on long-term scientific goals and priorities, as well as analyses and guidance concerning the scientific potential

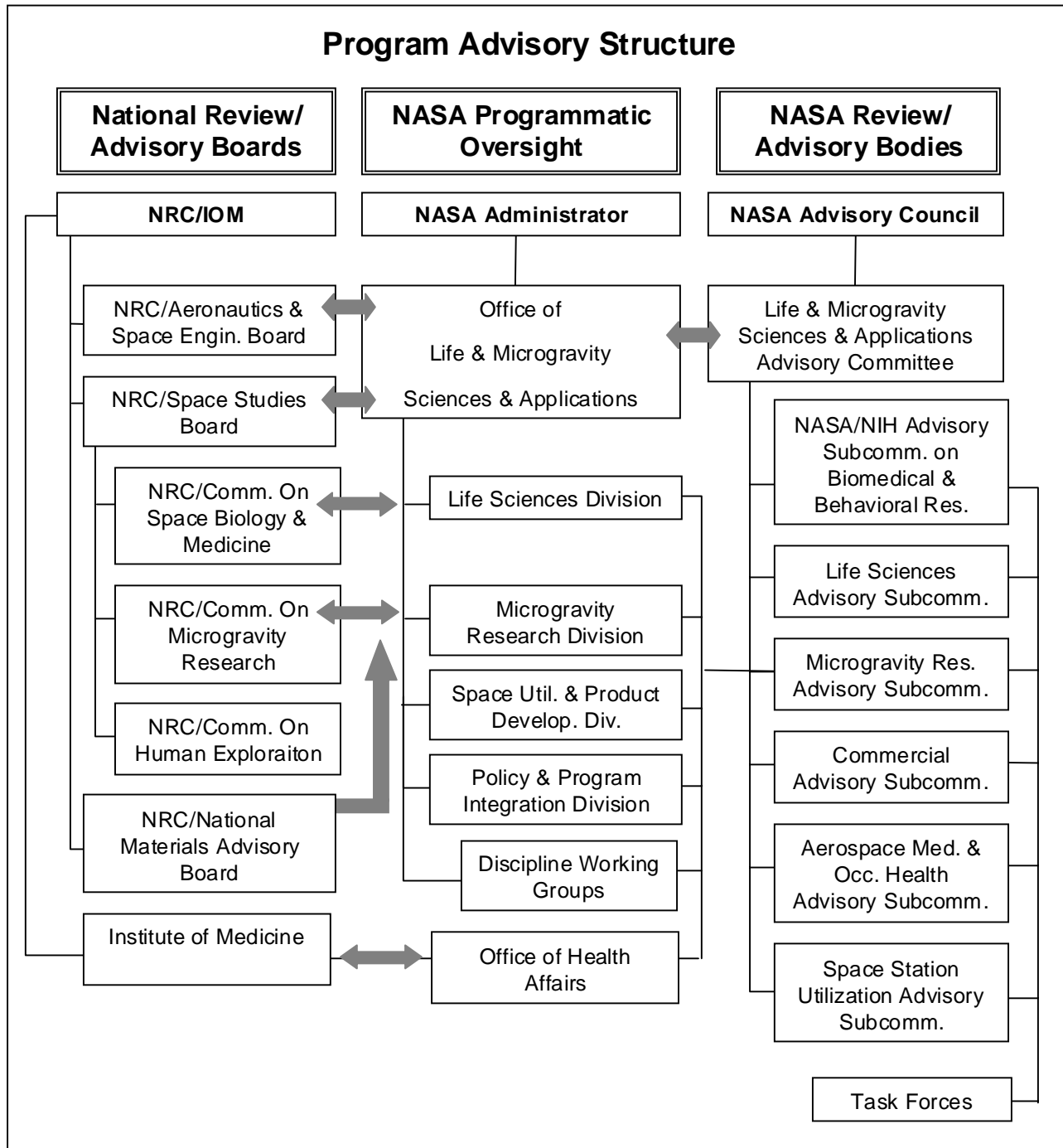


Figure 6

of research in the life and microgravity sciences. The advice that OLMSA receives from the NRC is critical to the formulation of OLMSA's research programs and priorities. OLMSA regularly briefs the committees of the NRC on plans and programs' status and commissions studies on specific topics of interest as needed. OLMSA receives additional external advice on medical matters from the Institutes of Medicine (IOM).

As OLMSA implements its strategic vision in pursuit of the broader scientific goals it has identified with the NRC, the office turns to the NAC for detailed advice and analysis. The NAC supports individual programs with advice and analysis on the formulation and execution of performance goals, development of NRAs, and evaluation of performance against plans. The subcommittees of the NAC play an important role in evaluating performance on a regular basis.

From time to time, OLMSA establishes special task forces under the purview of the NAC or other expert organizations to advise OLMSA on special issues.

4.2 1996-1999 Reviews

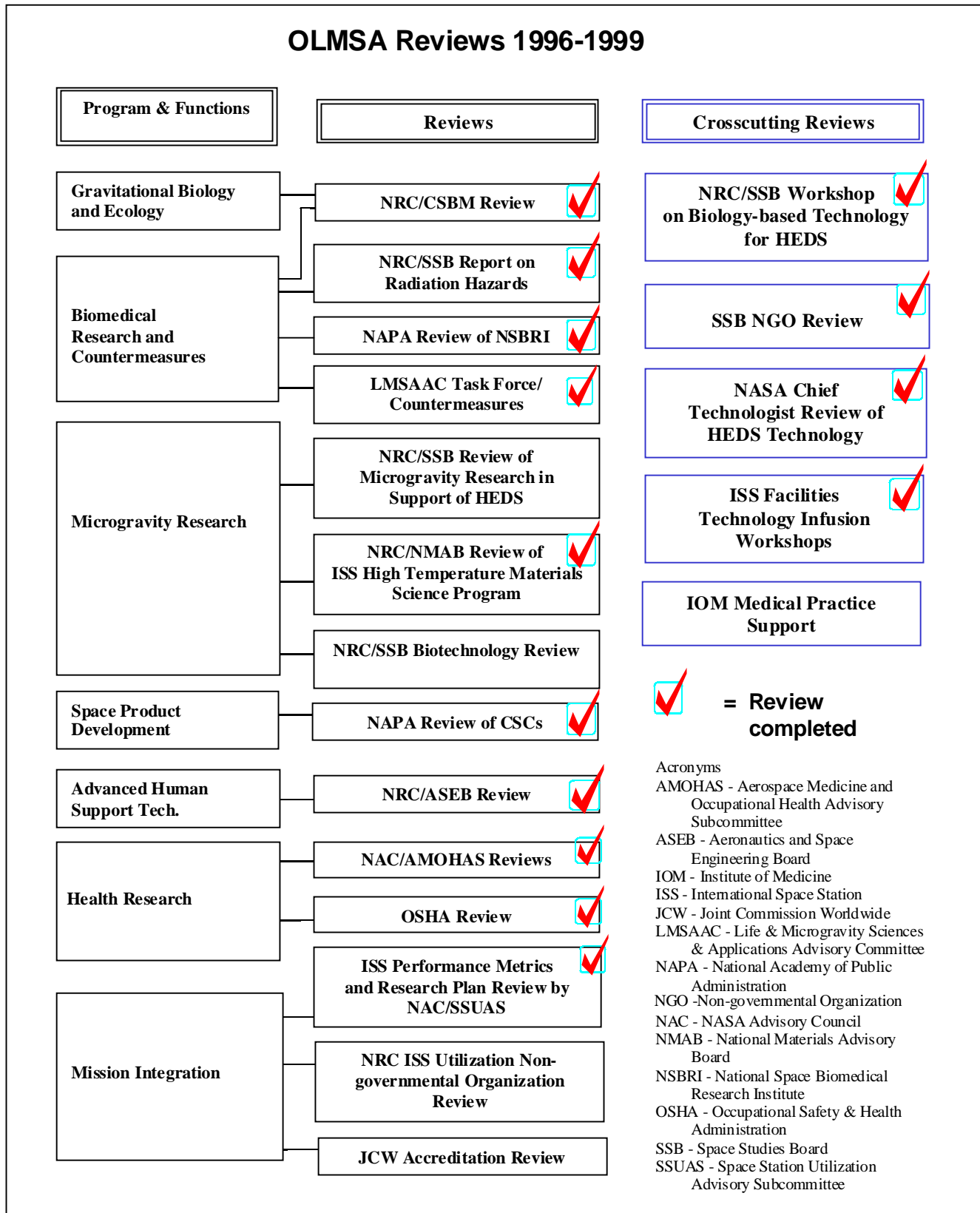


Figure 7

5. EXECUTING THE PROGRAM

5.1 The OLMSA Headquarters Organization

OLMSA manages its programs and functions through a series of four divisions and an Office of Health Affairs (see Figure 8). Division Directors and Office Managers report to the OLMSA Associate Administrator and support the Associate Administrator in developing enterprise strategy, establishing program requirements and metrics, advocating and explaining the program to external audiences, and developing long-term investment strategies.

5.2 The OLMSA Field Organization

Program implementation is the responsibility of designated Lead Centers (see Figure 9). The Lead Center has full program management responsibility and authority and thus full accountability for its assigned program. Each program is managed by its Lead Center to schedule milestones, budget guidelines, technical requirements, and safety and reliability standards.

The OLMSA Associate Administrator establishes specific performance-level requirements for each program but maintains the number of requirements to a minimum. Lead

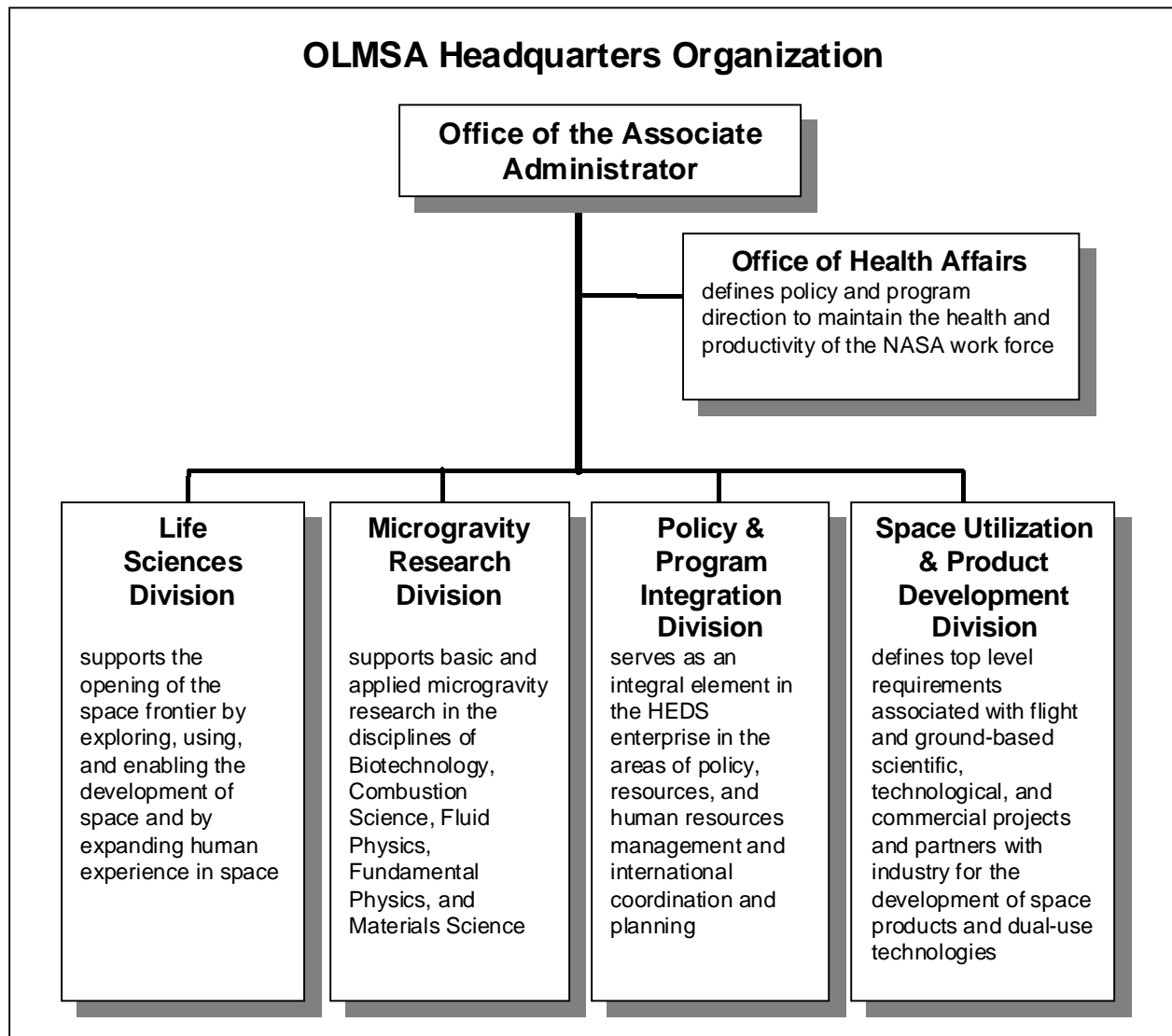


Figure 8

Center Directors establish supporting assignments for other Centers (see Figure 9).

5.3 OLMSA-Supported External Centers and Institutes

OLMSA relies upon an extensive external community of scientists, engineers, and commercial entities for the implementation of its programs. OLMSA has established, through competitive selection processes, a series of Commercial Space Centers, Commercial Space Technology Centers, NASA Specialized Centers of Research and Training, a National Space Biomedical Research Institute, and a National Center for Microgravity Research on Fluids and Combustion. OLMSA is also a partner in the Astrobiology Institute, which is managed by the NASA Office of Space Science. Each of the

OLMSA-supported Centers includes participation by a consortium of academic and/or commercial entities to leverage OLMSA resources and to encourage broad participation in research programs by the scientific, educational, and commercial communities.

National Space Biomedical Research Institute (NSBRI)

- The Institute is a consortium of seven universities (Baylor, Harvard, Johns Hopkins, MIT, Moorehouse, Rice, and Texas A&M) that leads a world-class, national effort in integrated space biomedical research. The consortium is headquartered in Houston, TX.
- NSBRI focuses on enabling long-term human presence in the development and exploration

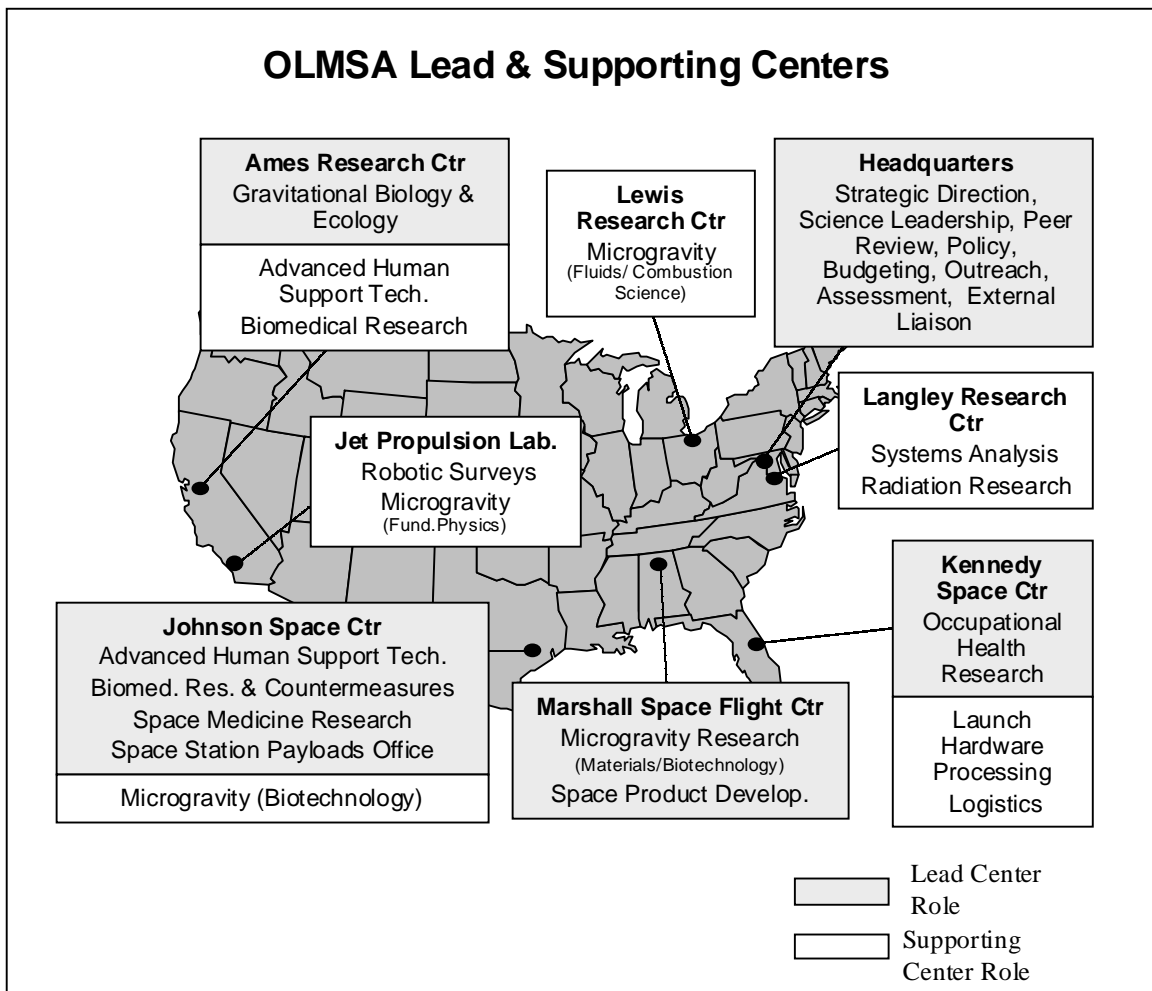


Figure 9

of space.

- The NASA-NSBRI agreement is for 5 years with options for three additional 5-year periods.
- An external review is conducted annually, with a NASA review every 4 years.

Space Biomedical Center for Training and Research (SBCTR)

- Located at Moscow State University, the SBCTR conducts research in telemedicine and distance learning.
- The center is the result of a cooperative agreement between the University, NASA, and the Russian Space Agency, with resource support from each entity.
- A NASA external review is conducted annually (NASA-funded from 1995-1999).

National Center for Microgravity Research on Fluids and Combustion

- A cooperative agreement signed with the University Space Research Association (a consortium of over 70 universities) and Case Western Reserve University established this center.
- The Center identifies and nurtures high value microgravity research, increases the transfer of research results to industry, contributes to improvements in science and engineering education, and provides support for the NASA exploration mission.
- The Center was established March 1997 with an agreement for 5 years with options for two additional 5-year periods.
- The Center coordinates a K-12 education

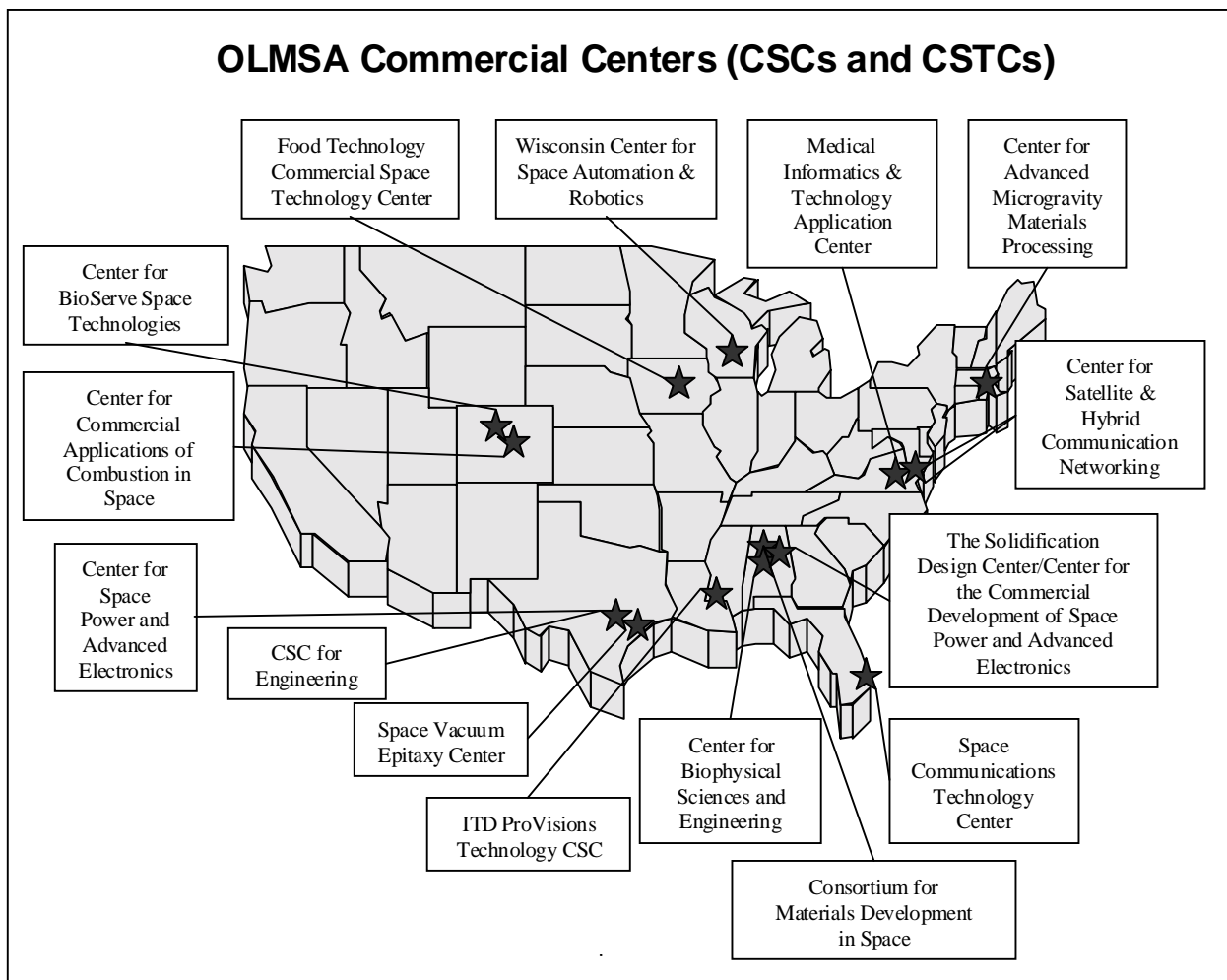


Figure 10

program, which includes curricula, hands-on student involvement, development of microgravity-based teacher and student internships, and a teacher sabbatical program.

OLMSA Commercial Centers (see Figure 10)

- OLMSA Commercial Space Centers and Commercial Space and Technology Centers are multidisciplinary consortia located at 16 sites. While all 16 Centers fall under the OLMSA policy umbrella, four Centers (Center for Space Power and Advanced Electronics, Center for Commercial Development of Space Power and Advanced Electronics, Satellite and Hybrid Communications Networks, and Space Communications Technology Center) are

managed by the Office of Space Science.

- Centers work with industry, academia, and government to facilitate the use of space for commercial products and services.
- Cooperative agreements between the Center and NASA are signed for 5-year periods and are renewable each year.

NASA Specialized Center of Research and Training (NSCORT) Program (see Figure 11)

- Eight multidisciplinary centers engage in research in the life sciences; provide a stable base for problem solving strategies; and involve students, research scientists, and engineers from academia and the public and private sectors.
- Grants are for five years; annual funding is

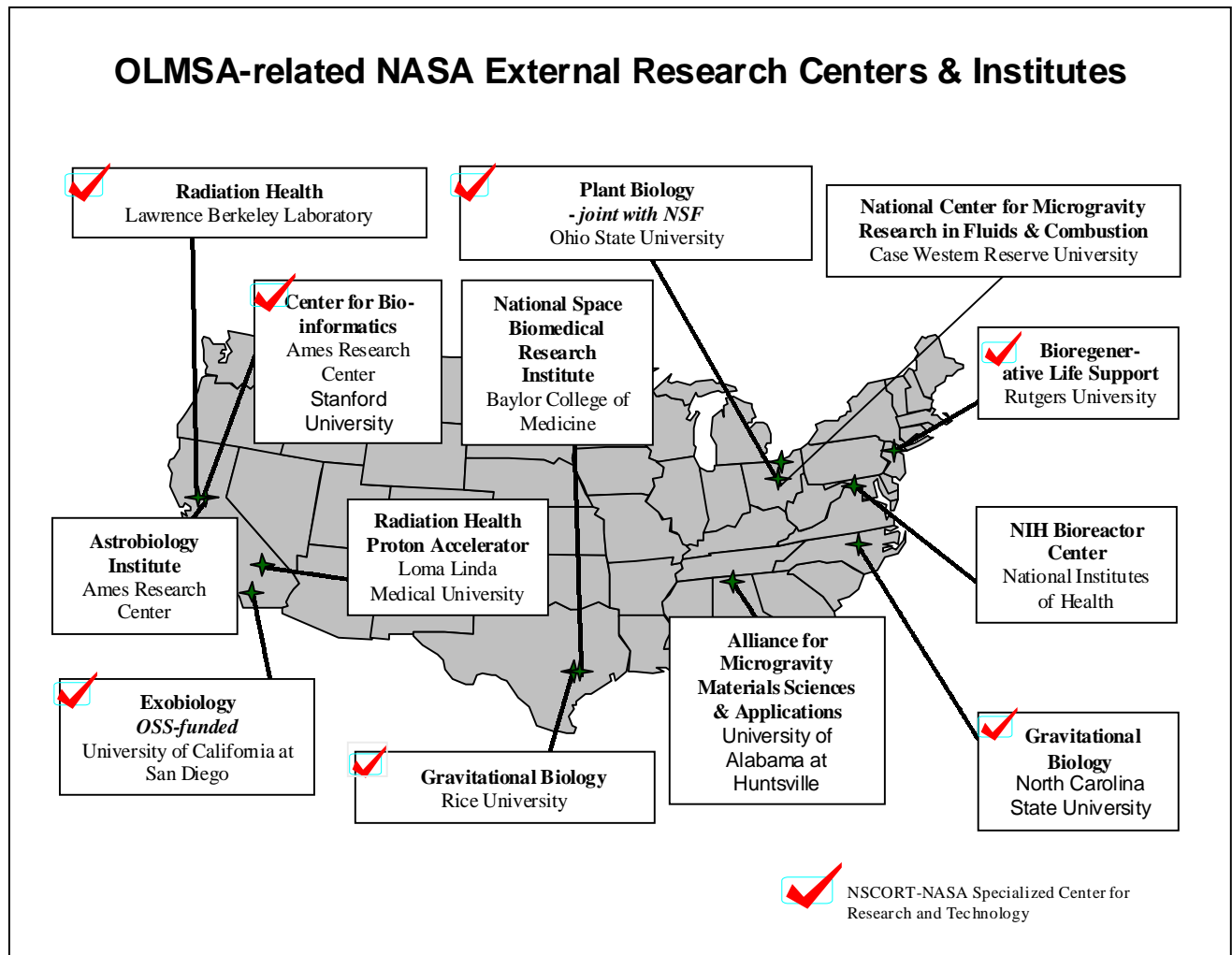


Figure 11

approximately \$1M for each center. Each center is peer reviewed every 5 years.

5.4 Integrated Schedule

OLMSA implements its programs through ground-based research; research on uncrewed, free-flying vehicles; Space Shuttle missions; and, in the future, on the International Space Station (see Figure 12). OLMSA employs this array of platforms in support of the broad strategic goals delineated above.

5.5 Unique Ground-Based Facilities

OLMSA's unique contribution to national research and development is based upon access to the space environment. However, many investigations selected and funded by OLMSA are performed through ground-based research, and all flight research is preceded by validated, ground-based research. It is possible to substantially reduce the effects of gravitational force for brief periods by achieving "free-fall," using either a parabolic flight in an aircraft or specially designed drop towers. In addition, laboratory techniques such as bed rest for human subjects, tail suspension for rats, special genetic

mutations, or the rotating wall bioreactor for tissue culturing can approximate the effects of space flight. Other ground-based techniques and facilities include access to specialized particle accelerators to simulate space radiation, specialized chambers for testing closed life-support systems, and suborbital rocket launches. This ground-based research forms the intellectual underpinning for OLMSA's flight research program.

KC-135 Aircraft

The KC-135 aircraft provides 25-second intervals of microgravity—up to 40 intervals per flight. The aircraft can accommodate a variety of experiments and is often used to refine space flight experiment equipment and techniques.

Sub-orbital Rockets

Use of sounding rockets allows scientists to take direct, experimental measurements during several minutes of microgravity within the Earth's mesosphere and lower thermosphere.

Drop Towers/Tubes

Several seconds of microgravity are obtainable

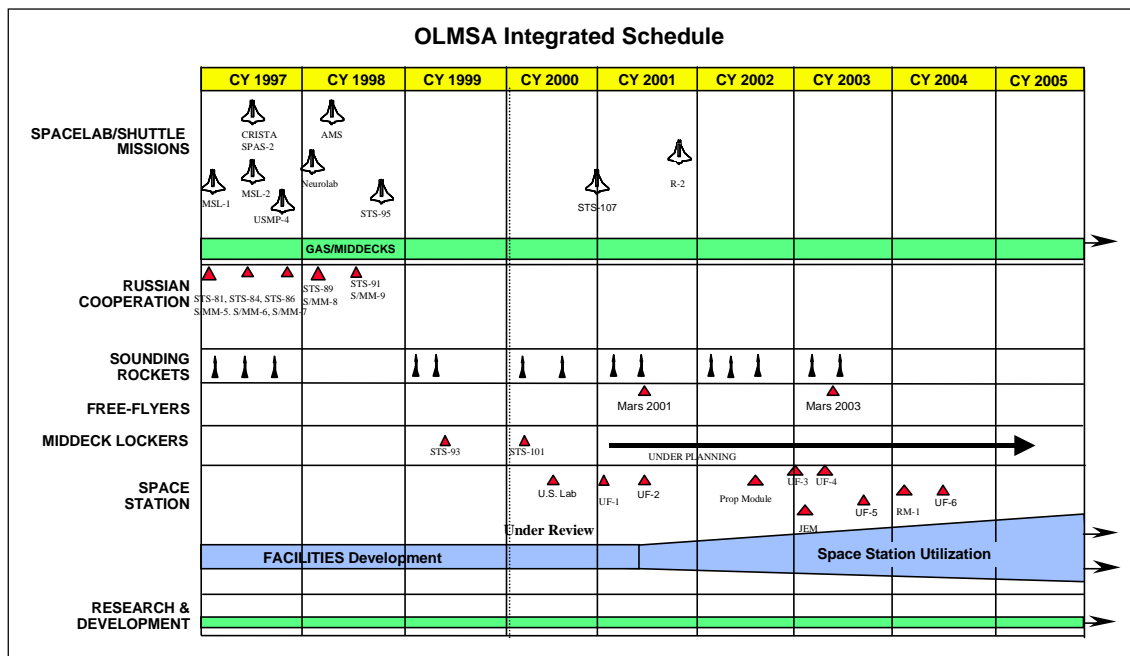


Figure 12

for experiment runs using NASA's drop tower facilities. NASA's drop towers allow researchers to capture visual data through the use of high-speed motion picture cameras. The drop towers also allow other data to be captured such as pressures, temperatures, and accelerations.

Centrifuges

NASA's centrifuges produce controlled, artificial gravity levels greater than 1 g. The centrifuges are used to conduct life sciences research on the effects of gravity and can accommodate a variety of biological specimens.

The Center for Bioinformatics at ARC and Stanford University

The center uses information and telecommunications technology to improve the reach and capability of medical expertise and practices. The Center's work has led to cutting-edge research into the application of virtual environments to medical imaging and education.

Radiation Research at Loma Linda Medical University

NASA's radiobiology research and the Visiting Investigator Laboratory examine how charged particles affect human equivalents and scientific

equipment. Begun in 1994, the NASA-Loma Linda collaboration uses ground-based research to complement space flight radiation exposure data.

Life Support Test Beds

Beginning in 2000, the Human Rated Test Facility at JSC will provide a human-rated, sealed environment for testing advanced life support and environmental control technologies. These test beds, which include the Lunar-Mars Life Support Test Project and the Bioregenerative Planetary Life Support Systems Test Complex Project, reduce technology risks and drive technologies towards higher states of maturity.

5.6 The International Space Station

As is evident from the integrated OLMSA schedule (see Figure 12), the International Space Station is expected to become the major platform for OLMSA research once assembly is complete. The Space Station will provide a continuous laboratory research opportunity and will substantially expand resources for space research (see Figure 13).

A suite of research facilities is planned for the

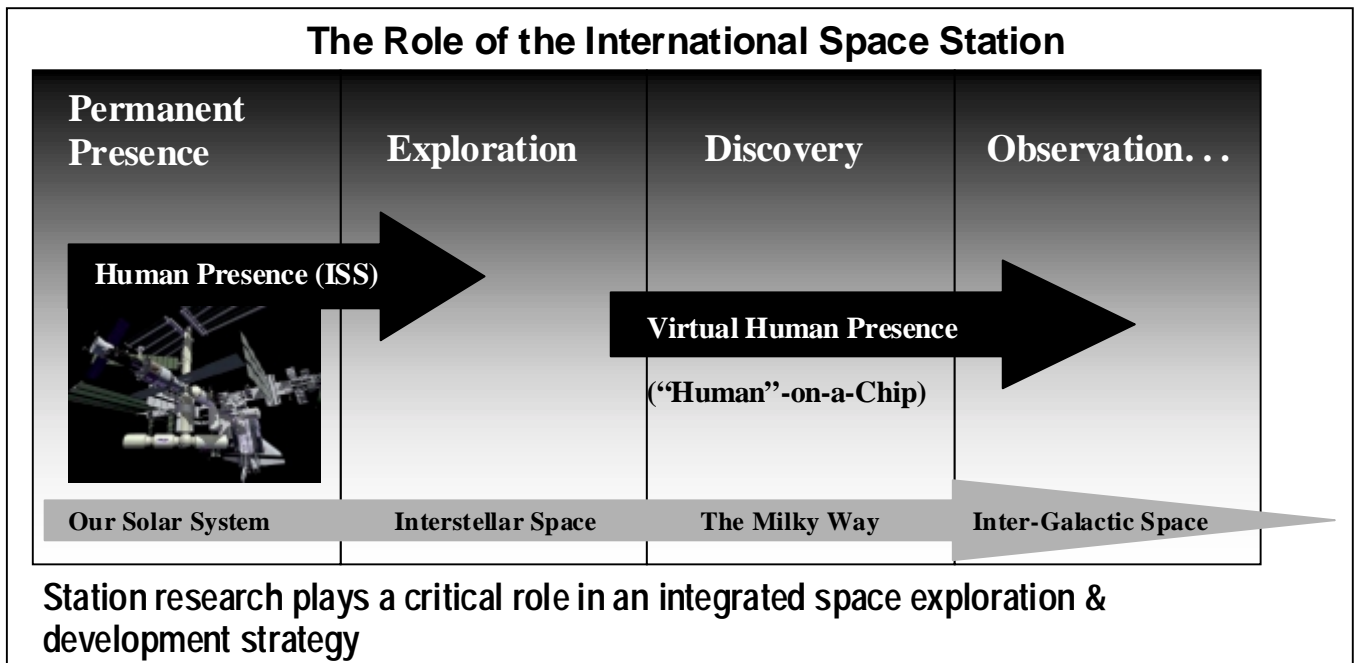


Figure 13

International Space Station. These facilities are being developed by NASA's Office of Space Flight in consultation with OLMSA. In preparing to take advantage of these research facilities, OLMSA is in the process of building up its base of Principal Investigators.

Allocation of U.S. resources (e.g., power, volume, crew time) on the International Space Station will become central to planning and executing OLMSA's research program. NASA has established a Space Station Utilization Board (SSUB), chaired by the OLMSA Associate Administrator, which is charged with developing plans for allocating Space Station resources for U.S. participants. Of the total resources allocated to the United States, NASA's initial policy is to devote 30% of internal Space Station resources for microgravity science research, 30% for life sciences research, 30% for commercial research, and 10% for projects sponsored by NASA's Office of Space Flight. The SSUB will adjust these allocations based upon the productivity of each community over time. The policy for payloads attached to the exterior of the Space Station is under development.

6. COOPERATION & COLLABORATION

6.1 International Cooperation

International cooperation enhances the quality of OLMSA research and leverages OLMSA resources through cooperative contributions of hardware and expertise. NASA's Office of External Relations oversees the development of agreements with international partners. The vast majority of OLMSA space flight missions incorporate international cooperation. Space Shuttle missions have routinely included investigations, equipment, and facilities developed by international partners. The recently concluded series of missions to *Mir* have demonstrated the importance and value of continued cooperation in preparation for the collaboration on the International Space Station.

OLMSA's peer-reviewed research selection process is open to international participants. However, OLMSA does not fund international research once it has been selected. Funding typically comes from the nation from which the proposal originates.

OLMSA participates in international working groups to coordinate NASA-sponsored research in the life and microgravity sciences with the work undertaken in these fields in the broader, international scientific community. The International Space Life Sciences Working Group (ISLSWG) is composed of participants from six space agencies: CNES (France), CSA (Canada), DLR (Germany), ESA (Europe), NASA (United States), and NASDA (Japan). ISLSWG developed a Strategic Plan for Space Life Sciences that guides the actions of member agencies in the field. Similarly, the International Microgravity Strategic Planning Group (IMSPG) acts in a coordinating role for the microgravity sciences. Membership in the microgravity sciences group mirrors that of ISLSWG, with the addition of ASI (Italy).

International cooperation will enter a new, expanded phase with the assembly of the International Space Station. International partners will develop and deploy facilities and have access to a designated share of Station resources. OLMSA works with the international partners to ensure that the return on various national investments is maximized. Strategic planning working groups coordinate national research programs and arrange for shared access to facilities, while avoiding duplication of facilities development costs. Figure 14 illustrates a framework for international research collaboration on the International Space Station.

6.2 Cooperation with Other Federal Agencies and Departments

OLMSA conducts a broad range of consultations and cooperative activities with other federal

agencies and departments as a routine element of planning and program development. It is the responsibility of programs to seek out opportunities for synergy and cooperation across the federal government. OLMSA has executed a series of Memoranda of Agreement and Understanding with other federal agencies, has sponsored and attended numerous workshops and symposia organized around themes common to multiple federal agencies, and has attended regular meetings of various coordinating bodies.

These activities will continue as OLMSA seeks to expand cooperation within the U.S. government. OLMSA's primary partner agencies and departments have been the National Institutes of Health, the National Science Foundation, the Department of Defense (including work specific to the Defense Advanced Research Projects Office), the United States Air Force, the Office of Naval Research, other defense organizations, and the Department of Energy.

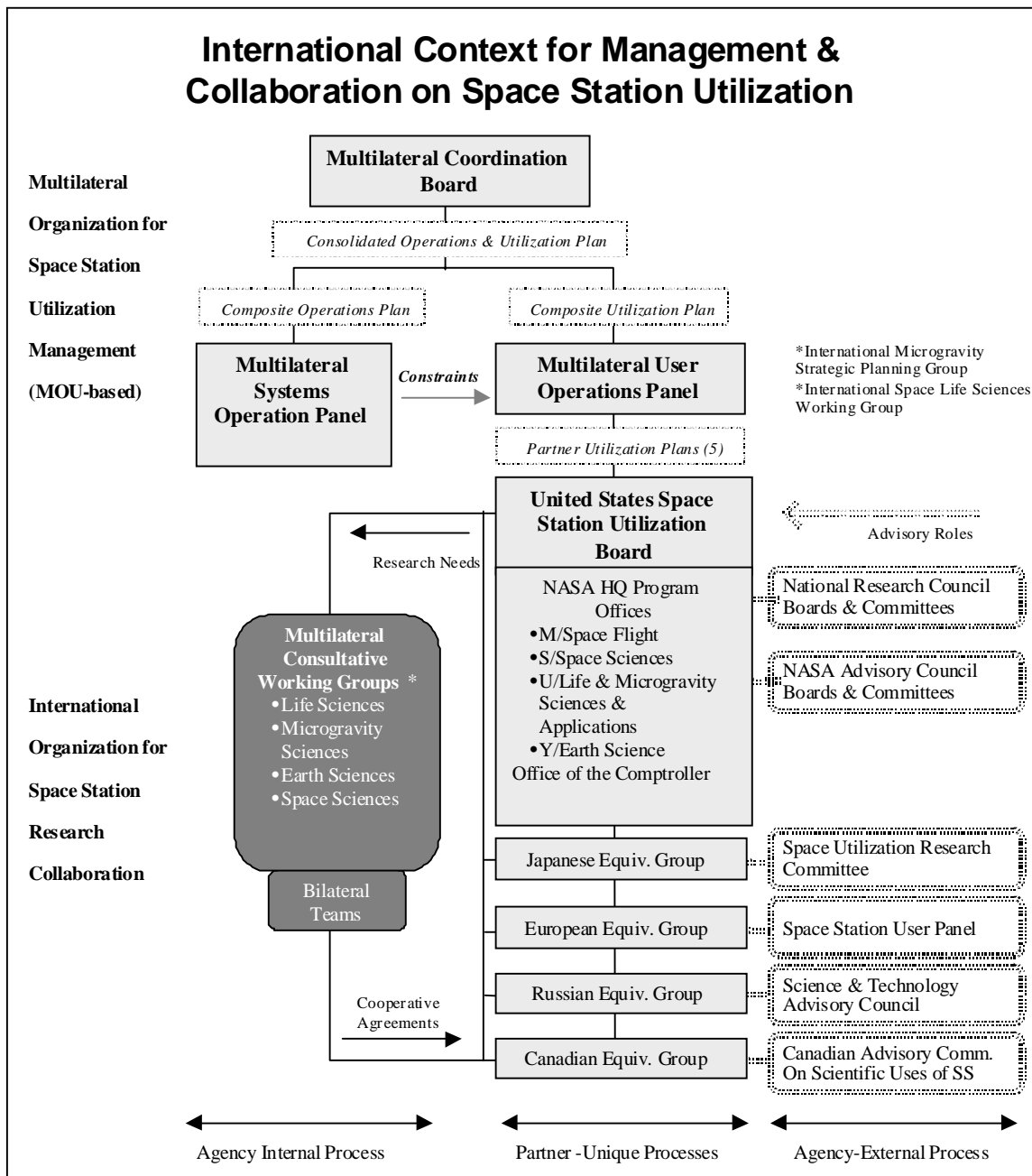


Figure 14

OLMSA has established over 23 cooperative agreements with the National Institutes of Health (NIH), including 18 Memoranda of Understanding (see Appendix B). Cooperation with the NIH includes joint workshops on scientific topics of mutual interest, jointly funded projects, a highly successful effort in technology transfer of advanced cell culturing technology, and cooperative flight experiments. An agreement signed in September 1997 between OLMSA and NIH/National Institute on Aging led to biomedical research on STS-95 with a focus on the aging process.

The National Science Foundation was a partner in Neurolab, a Space Shuttle/Spacelab mission dedicated to research on the nervous system that flew in April 1998; data analysis is ongoing. HEDS and the NSF have held cooperative discussions on nanotechnology, biomedical technology, and bioengineering.

Areas of cooperation with the Department of Energy include the use of ground-based facilities for simulating and studying the physical and biological effects of space radiation and a flight-based experiment for the ISS - the Alpha Magnetic Spectrometer.

OLMSA and the Department of Defense have held discussions on the provisions of health care in extreme environments. OLMSA and the Armed Forces Radiobiology Research Institute cooperate on radiation biology studies of mutual interest. The Office of Naval Research was a partner with NASA and NIH on Neurolab.

7. OUTREACH

NASA has identified outreach and program advocacy as a Headquarters responsibility. In practice however, the diverse, crosscutting nature of outreach activities necessitates a decentralized approach with the direct involvement of the NASA research community and program

personnel. OLMSA headquarters takes the lead in providing strategic guidance, fostering collaboration among OLMSA field center outreach efforts, and strengthening communication between OLMSA and other NASA headquarters offices: legislative affairs, public affairs, education, space flight, etc. OLMSA headquarters staff also focus on communication with Congress, the Administration, national societies, and, to a lesser extent, the press, which is a liaison role addressed by NASA Public Affairs representatives. The OLMSA field organizations play lead roles in pursuing outreach goals for professional societies, the general public, press, and other opportunities as they arise.

The following are some of the goals of the OLMSA outreach effort:

- support the Administration in securing congressional support for the President's budget;
- ensure that Congress and the Executive Branch have access to clear, accurate, and timely information on the content, budget, and schedule of our programs;
- enhance levels of scientific literacy among Congress, the media, educators, and the general public;
- expand understanding of the contributions HEDS makes to the quality of life of Americans; and
- establish a broad understanding of the content and benefits of the HEDS orbital research program.

Communications with our partners in the scientific community, other federal departments and agencies, and our international partners are excluded from this definition because these communications proceed through the channels described above.

OLMSA pursues its outreach goals through the following opportunities:

- formal briefings to Congressional committees and staff, the Office of Management and Budget, and the Office of Science and Technology Policy;
- courtesy visits and individual briefings for members of Congress, leaders of nonprofit organizations, and other leaders and decision makers;
- displays, materials, presentations, and speaking materials for major meetings of societies and organizations;
- presentations to invited guests at major mission events;
- interviews and materials for journalists; and
- an array of internet Web pages maintained at Headquarters and at the NASA field centers.

OLMSA's research outreach efforts have two separate but complementary objectives:

- (1) dissemination of research activities and goals in microgravity science, life science, safety and health, and commercial research; and
- (2) communication of the outcome/relevance of those research efforts, including public involvement/participation.

7.1 OLMSA Outreach Web Pages

OLMSA web page

<http://www.hq.nasa.gov/office/olmsa/>

Space Life Sciences Outreach

<http://weboflife.arc.nasa.gov/>

Life Sciences Data Archive

<http://lsda.jsc.nasa.gov>

Microgravity Research Outreach

<http://www1.msfc.nasa.gov/NEWMsfc/slrg.html>

Space Academy

<http://liftoff.msfc.nasa.gov>

Spacelink

<http://spacelink.nasa.gov>

Spaceflight Web Page

<http://spaceflight.nasa.gov>

7.2 Major OLMSA Outreach Efforts

Apart from the education activities noted below, OLMSA's major outreach efforts center around ongoing events, such as conferences, newsletters, OLMSA headquarters and field center web sites (noted above) that provide the current status of research efforts, and special events. For example, during 1998, OLMSA provided outreach through exhibit activity including the American Association for Retired Persons' convention; the American Public Health Association convention; the National Manufacturers' conference; and the American Association for the Advancement of Science convention. Special events included: OLMSA's participation in the Space Station videoconferences in February 1998 and 1999; OLMSA's support to the NASA Technology Showcase exhibit to Congress in June 1998; the Challenger learning project in September 1998; and the STS-95 research brochure.

8. EDUCATION

As with outreach, OLMSA's efforts in the field of education are largely decentralized. Each program includes an educational component, either through participation in broader Agency or Center level activities, or through individual initiatives within specific programs. OLMSA coordinates its educational activities with both the HEDS enterprise and NASA's Education Division in the Office of Human Resources and Education.

OLMSA's overarching educational goals are to:

- combine OLMSA's unique mission with the natural interest evoked by life and microgravity sciences and applications and aerospace medicine and occupational health

to encourage students in K-14 to develop scientific literacy and to select college majors in science and engineering disciplines;

- prepare the next generation of researchers by focusing on undergraduate and graduate students in science and engineering programs (particularly under-represented groups);
- increase the opportunities for "hands-on" experience in life and microgravity sciences and applications, aerospace medicine, and occupational health; and
- use modern telecommunications technologies and other methods to establish mechanisms for interactive dialogue between OLMSA and the educational community to communicate status information regarding OLMSA educational activities.

OLMSA contributes to many Agency- and program-level activities, including teacher enhancement, student research opportunities, institutional involvement in research, and student enrichment opportunities. OLMSA is also pursuing methods and implementation processes that ensure wider distribution of its educational opportunities in order to increase diversity.

Among its many contributions, OLMSA supports the NASA/NRC Resident Research Associateships and Graduate Student Researchers Program. The Space Life Sciences Teachers' Program continues to increase its student participation in spite of budgetary constraints. These increases include both women and minority applications and selections. Educational products such as the *Microgravity Teachers' Guide* are being revised to include several additional experiments and/or tutorials.

In addition, OLMSA participates in national conventions and symposiums such as the National Science Teachers Association (NSTA), the National Council of Teachers of Mathematics (NCTM) and the International Technology Education Association (ITEA).

OLMSA participates annually in NASA Teacher Update Videoconferences for teachers, students, and industry specialists. OLMSA, in agreement with the Space Station Office, also participates in a PBS videoconference focused on research that will be conducted on the International Space Station. The primary audience for this videoconference includes colleges, businesses, and hospitals.

OLMSA has developed a *Microgravity Teachers' Guide* that incorporates mathematics and classroom demonstrations to motivate greater interest among students (K-12) in mathematics, engineering, science, and technology.

9. APPENDIX A: OLMSA POLICY ON THE REVIEW, SELECTION, AND SUPPORT OF RESEARCH

9.1 Background

The Office of Life and Microgravity Sciences and Applications (OLMSA) is responsible for a broad range of ground-based and space-based research in support of NASA's Human Exploration and Development of Space (HEDS) strategic enterprise. OLMSA supports research, technology development, and commercial space product development in the areas of advanced life support technologies, biological sciences, biomedical research, biotechnology, combustion science, fluid physics, fundamental physics, materials science, and occupational health to advance understanding and to provide the foundation for future NASA missions.

9.2 Scope

This policy covers all OLMSA research and development activities in which OLMSA sponsors, selects and/or supports science, technology or commercial investigations. An investigation is defined as a research project or task funded or supported from any of the following sources: a program grant, A Science Institute or Center, a NASA Specialized Center of Research and Training (NSCORT), a Commercial Space and Technology Center (CSTC), or a Commercial Space Center (CSC). The number of investigations is a metric associated with the volume of OLMSA-related research conducted in the community. OLMSA is defining a uniform manner in which investigations are documented for the purposes of measuring the volume of research which is being supported. All technology development, ground, or flight research grants that are provided funding in the fiscal year or the number of industry-driven research activities, as defined in a certified Commercial Selection Criteria document, are counted as investigations. A

payload is defined as all apparatus required to support an investigation or a set of investigations in the case of multiple samples.

This policy does not apply to non-research activities in operational medicine, the implementation of counter measures, or to wholly commercial activities where selection is not approved by OLMSA. OLMSA is establishing this policy to define the process by which research planning, solicitation, selection and implementation will be carried out to ensure both the quality of research and the relevance to HEDS strategic goals and objectives. This policy shall also cover the termination of research activities for which the selection rationale or other conditions have changed substantially. In the case of payloads selected for scientific research, these considerations will include changed research priority, lack of a flight opportunity within 3 years of selection for flight, or inadequate investigator progress in completing the tasks outlined in the grant or contract agreement. In the case of payloads selected for commercial purposes, these conditions will include changed research priorities, lack of flight opportunities, and/or failure to meet the established business plan, milestones, or other agreements.

9.3 Policy

This OLMSA policy covers: a) science and technology research, b) space product development, and c) review and assessment.

a) Science and Technology Research. OLMSA will maintain a rigorous review and selection process to ensure the quality of research in ground-based and space-flight programs. This formal process will include the review of proposals using a peer process involving impartial national and international researchers from academia, non-profit federally funded research institutions, industry, and government as appropriate. The OLMSA review process provides an evaluation and recommendation of

only the highest quality proposals for selection by the appropriate NASA official as designated by the Associate Administrator, OLMSA. A condition for selection of a proposal will be the commitment of the Principal Investigator to the prompt publication and dissemination of the results in the open literature, considering any period of exclusive use.

The selection of an international proposal as part of an OLMSA research program or mission will require the same process as a U.S. proposal although no NASA funding will be provided to the non-U.S. investigator. Intramural activities involving the evaluation and validation of technologies, protocols or medical countermeasures for crew health protection may require an expedited peer review process and waiver of the competitive selection process when approved by the Associate Administrator, OLMSA.

The quality, relevance and effectiveness of the solicitation, review, selection and termination processes will be reviewed annually with the Associate Administrator, OLMSA, and with the relevant NASA advisory committees.

b) Space Product Development. OLMSA supports commercially sponsored research to facilitate the use of space for commercial products and services. The principal vehicles for these activities are the Commercial Space Centers (CSC): non-profit entities partnering with industry, university and government organizations, focused on a specific technological or potential commercial market area, and supported by a cooperative agreement and space research opportunities.

Prior to releasing competitive solicitations for CSCs, a committee will be established by the Associate Administrator, OLMSA composed of two representatives each from the HEDS enterprise, the LMSAAC and technical experts at NASA field centers, plus a representative from

the NASA Office of General Counsel. The committee will consult with independent industrial and financial experts to determine the business potential for CSCs in specific markets and will submit a written recommendation to the Associate Administrator, OLMSA as to whether a competitive solicitation should be undertaken. Following a solicitation, proposal review criteria will include competence, adequacy of ground support facilities, support from the host organization and degree of commitment from commercial affiliates. The decision to establish the CSC and the selection of the host organization will be made by the Associate Administrator, OLMSA.

Commercial flight research investigations must be sponsored by a commercial entity, which is either a member of the CSC or has a Space Act Agreement with NASA for commercial research. Each research activity, comprising one or more in-space investigations, must satisfy the requirements of the Commercial Selection Criteria (attachment A) in a document provided to NASA. The Commercial Selection Criteria are approved by the Associate Administrator, OLMSA.

Flight manifest priority will be determined by NASA based on:

- a clear plan for new or enhanced product development using the environment of space;
- the compatibility of the research requirements with the mission capabilities;
- the flight performance record of the CSC;
- the level of commitment (cash and in-kind) of the commercial entity;
- the record of the commercial entity in utilizing the flight results to market competitive products;
- the identification of their association with the NASA in-space research activities in their annual report; and
- the publishing of research results in the open scientific, technical and/or business literature

once the intellectual property rights have been satisfied.

For each commercial research payload flown on a Shuttle mission, ISS flight increment or other suitable platform, the CSC will incur a charge of \$1000/lb. per payload not to exceed \$20,000 per payload flight. The maximum charge to a CSC in a fiscal year is \$50,000. This charge will be deducted from the NASA funding, with the objective that the CSC recover the charge from the participating commercial entity. This charge may be waived by the Associate Administrator of OLMSA under special circumstances.

Government funding for the development and fabrication of research hardware must be approved by NASA.

The quality, relevance and effectiveness of the NASA commercial evaluation, selection and termination processes will be reviewed annually with the Associate Administrator, OLMSA and the relevant NASA advisory committees.

c) Review and Assessment. The integrity of the entire process for the scientific, technological, and commercial areas will be ensured through reviews conducted with the help of scientific and technical organizations such as the National Academy of Sciences and the National Academy of Public Administration, every 4 years. These reviews shall address the objectivity, quality, and effectiveness of the review and selection process, and contribution to the accomplishment of the program objectives. The reviews will also provide recommendations to NASA on potential improvements to the processes.

Effective date: This policy is effective on the date of issuance with the signature of the OLMSA Associate Administrator.

9.4 Attachment A: Commercial Selection Criteria

The goal of the OLMSA Commercial Program is to facilitate the use of space for commercial products and services. By so doing, the program contributes to U.S. economic growth, to the development of competitive products and services, to the creation of jobs, and to our quality of life. Support for research activity depends upon the envisioned product and its commercial potential and impact. Each commercial research activity must meet the following criteria, with suitable documentation provided prior to final manifesting.

First criterion: Technical Assessment

- The need for space is clearly defined and justified.
- The technical approach is feasible and supports development of the product.
- Requirements for technology development are clearly identified with adequate funding plans.

Second criterion: Business Plan

- A non-U.S. Government market is defined and is of sufficient size.
- There is evidence that the needs of the target market can be met.
- There is a commercial affiliate(s) who provides evidence of the necessary resources, capability, planning, and experience to bring the product to the market.
- The proposed activity is essential to product or service development and is consistent with business planning.
- A roadmap exists; it includes the essential activities to bring the product to market beyond the development space activities.
- Significant private resources (financial and in-kind) are at risk.

Third criterion: Space Access

- The required space opportunities exist to accommodate stated research needs.
- The space research requirements are consistent with potential product benefits.

Fourth criterion: Funding Adequacy

- Funding requirements are identified and justified.
- The commercial affiliates provide evidence of funding commitment for the research program.
- Government funding is available and consistent with the required commitment.

Fifth criterion: International Collaborations

- The research activity clearly demonstrates the benefit to the U.S. taxpayer.

Sixth criterion: Animal Research

- Research activities that involve animals, or cell tissues derived from animals, must have documented approval from the Institution Animal Care and Use Committee, of that institution or commercial partner.

10. APPENDIX B: NASA/NIH AGREEMENTS AND RECENT ACTIVITIES

10.1 Cooperative Agreements

NASA/NIH Cooperative Agreements		Date of Initiation
Biomedical/Behavioral Studies	NASA/NIH	July 1992
Animal Science Research	NASA/NCRR	July 1992
Research into processes of aging and space flight	NASA/NIA	September 1992
Neurologic Functions ¹	NASA/NINDS	October 1992
Vestibular Research ²	NASA/NIDCD	October 1992
Medical Diagnostic Imaging	NASA/NCI	March 1992
Musculoskeletal Research	NASA/NIAMS	December 1992
Neurolab Review	NASA/NIH-DRG	February 1993
Cardiovascular, pulmonary, and hematologic studies ³	NASA/NHLBI	September 1993
Human Brain Project ⁴	NASA/NIMH	September 1993
Developmental Biology	NASA/NICHHD	January 1994
Spaceline Bibliographic Database ⁵	NASA/NLM	February 1994
Human Brain Project	NASA/NIMH	March 1994
Cancer Research	NASA/NCI	July 1994
Human Brain Project	NASA/NIMH	July 1994
Biomedical Research	NASA/NCRR	August 1994
NASA/NIH Center for Three Dimensional Tissue Culture ⁶	NASA/NICHHD	October 1998
Human and Animal Research Education and Technology Development	NASA/NCRR	August 1994
Global Monitoring & Disease Prediction ⁷	NASA/NIAID	September 1996
Laser Light Scattering/ Cataract Research	NASA/NEI	November 1996
High Brilliance X-ray/ Protein Crystallography	NASA/NIH	October 1996
Genomic Instability	NASA/NCI	June 1997
Space Flight and Aging ⁸	NASA/NIA	September 1997

Supplement to NHLBI grants: January 1999.

10.2 Recent Activities

1. Joint Workshop between NASA and the National Institute on Neurological Disorders and Stroke on nerve regeneration and spinal cord injury held in December 1997.
2. Current active solicitations with the National Institute for Deafness and Other Communications Disorders for proposals in two areas: Vestibular Research and Hearing Aid Technology.
3. NASA offers supplements to National Heart, Lung and Blood Institute research centers to include research in space physiology.
4. Human Brain Project: NASA/NIMH April 1998.

Human Brain Project: NASA/NIDCD June 1998.
5. The National Library of Medicine (NLM) maintains a bibliographic database that is available on the Internet and includes space-related medical research publications (www.ncbi.nlm.nih.gov/PubMed/).
6. NASA has established a center within the National Institute for Child Health and Human Development that conducts research

in various aspects of tissue biology using the NASA Bioreactor and trains NIH and university scientists how to use this technology.

7. NASA is providing supplements to grantees of the National Institute on Allergy and Infectious Diseases to use NASA remote sensing data for infectious disease prediction. The Agreement has been renewed and updated as projects change.
8. NASA and the National Institute on Aging are developing joint research, on Earth and in space, to study the relationship between the physiological responses to space flight and the biology of aging.